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AUTHOR	Munkvold, Bjorn Erik; Line, Lars
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ABSTRACT

Distributed collaboration supported by different forms of information and communication technologies (ICT) is becoming increasingly widespread. Effective realization of technology supported, distributed collaboration requires learning and careful attention to both technological and organizational aspects of the collaboration. Despite increasing focus on the use of ICT in education, for example in the form of distance learning and computer supported collaborative learning, there still are few educational programs that include an explicit focus on providing the students with practical training in distributed collaboration. This paper presents the results and experiences from two student projects conducted at Agder University College in Norway, where groups of students from campuses in two different cities engaged in distributed collaboration supported by different forms of collaboration technology. The project illustrates how students perceived this form of distributed work to be interesting and stimulating, but also challenging and time consuming. Task definitions and balancing of motivational factors were found to have a great impact on the groups' efforts, sharing of workload and final outcome. Further, the projects also illustrate how "technical noise" and lack of experience with the technologies represented barriers to effective collaboration, implying a need for training the students in integrated use of different communication services. Based on the experiences from the two pilot projects, the paper presents practical implications for developing and conducting similar projects. Three tables include: key contents of pilot project 1; key contents of pilot project 2; and overview of technology use. (Contains 27 references.) (Author)

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TRAINING STUDENTS IN DISTRIBUTED COLLABORATION: EXPERIENCES FROM TWO PILOT PROJECTS

Bjørn Erik Munkvold
Agder University College

Lars Line
Agder University College

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ABSTRACT

Distributed collaboration supported by different forms of information and communication technologies (ICT) is becoming increasingly widespread. Effective realization of technology supported, distributed collaboration requires learning and careful attention to both technological and organizational aspects of the collaboration. Despite increasing focus on the use of ICT in education, for example in the form of distance learning and computer supported collaborative learning, there still are few educational programs that include an explicit focus on providing the students with practical training in distributed collaboration. This article presents the results and experiences from two student projects conducted at Agder University College in Norway, where groups of students from campuses in two different cities engaged in distributed collaboration supported by different forms of collaboration technology. The project illustrates how students perceived this form of distributed work to be interesting and stimulating, but also challenging and time consuming. Task definitions and balancing of motivational factors were found to have a great impact on the groups' efforts, sharing of workload and final outcome. Further, the projects also illustrate how "technical noise" and lack of experience with the technologies represented barriers to effective collaboration, implying a need for training the students in integrated use of different communication services. Based on the experiences from the two pilot projects, the paper presents practical implications for developing and conducting similar projects.

INTRODUCTION

Different forms of IT supported collaboration across geographical distance become increasingly widespread in today's organizations. This can be seen as a result of several factors. The development towards global and dynamic markets creates a need for flexibility in time and place for organizational work tasks. Further, the technological development has now reached a stage where different communication tools can be acquired "off the shelf, and where bandwidth and quality of communication no longer represent unobtrusive barriers to distributed interaction. Through combined use of different collaboration technologies like e-mail, desktop videoconferencing systems, application sharing and document exchange, distributed collaboration today can be equally effective as co-located work. Distributed collaboration here comprises different forms as related to organizational scope and time frame, and may include both intraorganizational

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collaboration between geographically dispersed units in large organizations, and project based networks among small and medium sized enterprises (Line, 1999a; Munkvold, 1999).

In academic research, virtual teamwork has long been presented as a key element in the "organizations of the future" (e.g., Cohen, 1993; Davidow & Malone, 1992; Keen 1991; Vitalari, 1990). However, it is only during the last five years or so that this has become reality, as a result of the technological development described above. These solutions thus have developed from "hype" into being characterized as "mission critical" by many organizations today. It is important here to realize that effective deployment of distributed collaboration does not come about by itself, but requires active learning and understanding of both technological and social aspects by the actors involved. It is therefore necessary for educational institutions to develop study programmes that provide the students with adequate background and training in this new form of work. While there is much activity today centred around the use of ICT in distance learning as a substitute for traditional classroom teaching, there are still few study programmes that offer explicit and practical training in effective, distributed collaboration.

This paper presents the experiences from two pilot projects in distributed collaboration among students, conducted at Agder University College (AUC) in Norway during fall 1998 and fall 1999. In these projects, groups comprising students from two different courses given at AUC's campuses in the cities of Kristiansand and Grimstad worked together on a project assignment over a period of two-three weeks. During this period, the groups collaborated entirely over the net, supported by a selection of different technologies for distributed collaboration: e-mail, application sharing, audio and videoconferencing, document repositories and discussion databases. Through presentation and discussion of the experiences from these projects, the goal is here to establish a foundation for further development of this type of educational offerings, and to stimulate discussion on the conduct of similar projects.

The article is structured as follows. The next section provides a brief overview of related research on distributed collaboration and use of ICT in education. This is followed by a description of the two pilot projects, and a subsequent discussion of the experiences from the conduct of these projects. The last section presents implications for developing similar projects for training students in distributed collaboration, as well as implications for further research and practice.

OVERVIEW OF RELATED RESEARCH

Distributed collaboration supported by IT is at focus in several research arenas. This section presents a brief overview of some of these research activities.

Computer-Mediated Communication

In the area of *Computer-Mediated Communication (CMC)*, studies of how "electronic communication" affects interpersonal interaction and collaboration in distributed settings have been conducted for more than two decades (e.g., Hiltz & Turoff, 1978; Short et al., 1976). Most of this research is of an experimental nature, being conducted in controlled environments (e.g., classroom settings) with students as subjects, working on artificial tasks. A large part of the research on distributed collaboration has focused on some form of teamwork, and different variables related to group dynamics and group characteristics have therefore constituted key elements in the research models developed. A range of different factors have been studied in these experiments, such as the effects of technology support on effectiveness and quality in decision processes, and participants' perception of process and outcome. A meta-analysis of the results from a selection of these studies indicates that users normally are capable of adapting to the changes in communication form implied by use of technology support, and that use of electronic communication does not result in reduced quality of outcome. In some cases it may even lead to better quality through stronger task focus and the possibility for more in-depth analysis (Munkvold, 1996). On the other hand, there are also several examples of how the time used for making decisions in this form of collaboration increases, and of team members reporting reduced satisfaction with the group process.

The experimental context in which these results are generated clearly limits the transferability to distributed teamwork in real organizations. Typical for these studies is also a focus on comparison between distributed and co-located ("face-to-face") teamwork. In several organizations, distributed collaboration will represent the only possible alternative due to

geographical barriers (Line, 1999a). Further, it is worth noting that the technology used in these studies often is limited to e-mail and text based conferencing systems, and does not include richer communication media like desktop videoconferencing and application sharing.

Virtual Teamwork

During the last five years there has been a growing interest in so-called virtual teamwork (e.g., Lipnack & Stamps, 1997), where team members collaborate from several geographical locations supported by different types of communication technologies. Much of the research related to this form of collaboration still suffers from the same limitations as earlier CMC-studies, i.e. lack of realistic context and limitations in technology support. Several projects that are being presented as "advanced" examples of virtual collaboration are actually based on e-mail as the only form of technology support (e.g., Knoll & Jarvenpaa, 1998).

Concurrent Engineering

While virtual collaboration in administrative office work until recently has had a rather "exotic" character, there is a long tradition in the engineering disciplines for this form of work. For example, in Norway the construction and oil industries have been early adopters of ICT for supporting coordination and information exchange between different actors. In general, the area termed *Concurrent Engineering (CE)* comprises several examples from different industries of relatively advanced, distributed collaboration projects regarding technology support and complexity (e.g., Ashby et al., 1995).

ICT in Education

In education today there is an increasing focus on the use of ICT both to enable new teaching methods and to increase efficiency for traditional instructional methods. This relates both to distance learning (e.g., Dede, 1996) and computer supported collaborative learning (CSCL) (e.g., Brandon & Hollingshead, 1999; McConnell, 1994; Seufert & Seufert, 1998). Fjuk (1998) introduces the term *Computer Support for distributed Collaborative Learning (CSdCL)* for denoting the intersection between these two areas, thus also including physical distance among the collaborating students. There is also an increasing use of Internet and the World Wide Web for supporting various forms of learning approaches (Bandi & Nakatani, 1998; Dufner et. al., 1999; O'Leary & Fischer, 1998). In general, the activity related to the use of ICT in educational settings is largely focused on supporting the learning process (e.g., Beranek & Loch, 1999; Vreede et al., 1999). There are still few courses that focus on how the technology can be used effectively to support distributed collaboration.

Conclusion

A conclusion from this brief overview of related research is thus that there exist few course offerings that focus explicitly on distributed collaboration *in practice*. Further, we argue that the research related to distributed collaboration supported by ICT is still at an early stage, at least if realism in context and use of state of the art technologies are applied as criteria for maturity. However, we need to stress that the projects reported in this study have had the character of practical pilot projects in an educational context, and therefore have not followed a stringent research design regarding data collection and analysis. The primary purpose of the projects has thus been to generate experiences that can form a basis for further development of instructional methods for training students in practical, distributed collaboration.

STUDENTS IN THE WILD — DESCRIPTION OF THE TWO PILOT PROJECTS

This section provides a description of the scope and conduct of the two student projects in distributed collaboration conducted at AUC during the fall terms of 1998 and 1999. Discussion of experiences and results from the projects are presented in the next section.

Background and Purpose

The idea for these projects was conceived during a discussion on how to develop common teaching modules for the following two courses:

Coordination Technology - second year course in the two year Master of Engineering programme in Information and Communication Technology (ICT) at the AUC campus in Grimstad

Computer-Supported Cooperative Work (CSCW) - first year course in the two year Masters

programme in Information Systems (IS) at the AUC campus in Kristiansand

By establishing distributed project groups across the two courses, the purpose was to give the students practical experience with distributed teamwork, including coordination and use of different forms of collaboration technology. The contents of the project assignment should be a relevant course topic and mimic a real world task as closely as possible. A third goal was to establish an arena for interaction between the students from these two programmes. This contact is normally restricted by the geographical distance (60 km) between the two study locations. So far, this project has been conducted for two successive years, with adjustments being made based on the experiences from the first year. In the following we provide a brief description of the two projects, including an overall evaluation of the results.

Pilot Project 1

The first project was planned during summer 1998 and started approximately one month after start-up of the semester. The assignment given was to compare the functionality of two "groupware platforms": Microsoft Exchange/Outlook and Lotus Notes/Domino. These two technology platforms were used this year as the basic infrastructure in the two courses, in Grimstad and Kristiansand respectively. Table 1 presents the key contents of the project.

Data Collection

Different forms of data collection were conducted during the project period, as a basis for the evaluation of the pilot project. The experience reports were specified at the outset as to include the following topics: the group's organization of the project, use of technology support, experiences from the collaboration in the group, and reflections on how the group would conduct a similar project in the future. By having the participants from each course hand in separate experience reports, we wanted to give them the opportunity for presenting their experiences and views related to sharing of workload and collaboration in general with the participants from the other course. The students were guaranteed that these reports would be confidential, read by the two instructors only.

In addition to the experience reports from the groups, a web based form for self-reporting of activities during the project period was created. The groups could also print out the form and fill this in manually. The groups were requested to hand in this activity log as an attachment to the experience report. Only three of the five groups used the form. This can be ascribed to several factors. First, the form was not available until a week after the project had started. Second, the instructions to the students were not sufficiently explicit on the need for appointing a group member as responsible for the logging of activities. Consequently, for some groups this was given low priority compared to the work on the assignment itself.

Overall Evaluation of the Project

Evaluation of the groups' results in the form of project reports and presentations shows that the groups to a varying extent managed to solve the task assigned (the project reports are available at http://siving.hia.no/ikt97/it4200/). All the groups had chosen to divide the project between their distributed units, so that the participants from each course were responsible for the groupware product available at their site. This could be expected, but both the reports and the related presentations revealed that several of the groups had not succeeded in coordinating the contents and presentation regarding comparison of the two products. For several of the groups their result was limited to including a separate description of the functionality for each product.

The project was reported by the students to be time-consuming and almost of an "absorbing" nature, at the expense of other course work. This must also be related to the fairly broad task assigned, requiring delimitation of focus by the students. According to several of the groups, the difference in evaluation form between the two courses also resulted in that motivation and effort put into the project was unequal among the participants from each course.

Lecturing continued as normal during the project period and the students were responsible for coordination and finding time for the project work. Some groups experienced difficulties with finding available time for synchronous sessions/meetings, due to the different schedules for the two study programmes.

Supervision was conducted in the form of the instructor at each site answering questions from students in his course. Thus, there was no supervision with the entire

group present. A problem with this form of "local" supervision was that different interpretations among the two instructors also occurred some times, thus leading to confusion and frustration among the students.

TABLE 1
KEY CONTENTS OF PILOT PROJECT 1

Pilot project 1
Assignment Comparison of Microsoft Exchange/Outlook and Lotus Notes/Domino on the following areas of functionality: E-mail, Internet integration, Application Development Environment, Database structure, Security
Deliveries Written report, half hour presentation in class. Two experience reports per group, from the participants from each course.
Evaluation/Incentives Part of the mandatory assignments for both courses. For ICT students the projects were graded, comprising 10 % of the total grade. For IS students the projects were graded as 'passed/fail'.
Schedule Prior to the project, students in both courses were given an introductory lecture on application sharing and some practical exercise with Microsoft NetMeeting. The project activities were scheduled as follows: Kick-off seminar at AUC Kristiansand. Introductory lecture on distributed collaboration. Forming groups, selection of topics. Lunch in groups, introduction/getting acquainted. 2 hours with group work on problem specification and planning. Concluding guest lecture from Lotus Notes vendor. Distributed project work for three weeks. No face-to-face contact between participants from the two courses. Group members from same course allowed to work face-to-face. Face-to-face supervision available from the course instructors in Grimstad and Kristiansand on request. Closing seminar at AUC Grimstad. Groups working for 2 hours finalizing their reports. Group presentations in class. Guest lecture from vendor focusing on comparison between MS Exchange/Outlook and Lotus Notes.
Group composition 6-7 person groups with 3-4 students from each course. 5 groups in all, with a total of 18 IS-students and 16 ICT students.
Infrastructure The students in both courses had a dedicated PC lab at their disposal, offering access to the following technologies/applications: E-mail (MS Exchange Outlook in Grimstad and Eudora Pro 3.0 in Kristiansand) Microsoft NetMeeting v. 2.01 Lotus Notes v. 4.5 (Domino) World Wide Web (WWW) Since MS Exchange/Outlook and Lotus Notes only were installed at one campus each, remote access to the tools was provided through use of MS NetMeeting and by accessing the products over the Internet through a web browser. To enable the last approach, guest accounts for remote login were created at each site.

Pilot Project 2

The project was repeated during the next conduct of the two courses the following year. Table 2 outlines the key contents of the second pilot project. Several changes were made based on the experiences from the first pilot project. In addition, the group composition was also different, due to uneven numbers of students in the two courses this year. The changes made are summarized in the following:

Task made simpler and more cohesive
The assignment in pilot project 2 was chosen on the basis that it was simpler, requiring less work for clarification and delimitation of focus and thus making it easier for the students to start on the actual work. Further, the task should be "cohesive" for the group, and not of a nature that invited for dividing subtasks between participants from the two courses.

Incentives made more equal
Incentives were made more equal for the two student groups, by grading the project in the IS course as well. However, due to practical concerns, the assignments still comprised different percentages of the total grade.

Shorter project duration
The duration of the project was reduced to two weeks, to avoid taking up too much time during the semester.

More time for group work during the kick-off seminar
The time for group work during the seminar was extended somewhat, to give more time for planning the project and building relationships.

Coordination of course schedules
The schedules for the two courses were coordinated to make it easy for the students to find time for synchronous collaboration.

Group-wise supervision
Each group was assigned one instructor as supervisor, to ensure consistent advice and avoid redundant information.

Group composition
Due to changes in the Master programme in Kristiansand, the number of IS students participating in the project this year was considerably less than for the ICT students, leading to uneven numbers in the groups. This made it necessary to form two groups comprising ICT students only. Most of the students in these groups worked from the same location (three of them were part time students and therefore worked in a "real" distributed setting), but were asked to "simulate" distributed collaboration by using electronic communication only.

Appointment of "observers"
One ICT student in each group was assigned the role as "observer" with responsibility for logging technology use and process data for the experience reports.

Regarding infrastructure, the same technologies were available as for project 1 (with some upgrades) with the addition of two PCs with Intel Proshare, supporting desktop videoconferencing. Further, mobile telephones were found to be frequently used by the students, although not being part of the "designed" project infrastructure.

Data Collection

Similar to the first pilot project, the experience reports including the log of communication sessions were the main source of data. In addition, pre and post surveys were conducted for the second project. The pre survey was conducted at the end of the kick-off seminar, asking the students about their previous experience with distributed collaboration, and their expectations for the distributed project regarding efficiency, quality of outcome and personal satisfaction as compared to traditional, co-located teamwork. The post survey was conducted after completion of the project by using the GroupSystems survey tool. The IS students completed the survey in class, giving 8 out of 8 possible responses. Due to limited installation of GroupSystems in Grimstad, the GroupSystems form had to be distributed by e-mail to the ICT students. 15 out of 31 possible responses were returned, giving a total response rate for the survey of 59 %. The post survey covered the students' experiences from the project regarding perceived quality and efficiency, and their satisfaction with the process and learning outcome. The analysis showed no significant differences in the answers between the two student groups. The results from the two surveys will here only be used for supporting the analysis of the experience reports in the next section.

TABLE 2
KEY CONTENTS OF PILOT PROJECT 2

Pilot project 2
Assignment Developing a web-site presenting information on one of the following technologies: Palm PCs, PC-based real-time conferencing, Electronic meeting support systems, Workflow, Document administration, Streaming multimedia. The web-site should cover the following parts: introduction and overview of the area, presentation of a framework for comparison of related products, product overviews and links to related research and communities.
Deliveries Web-site, 20 minute presentation in class. Two experience reports from each group, from participants from each course.
Evaluation/Incentives Part of the mandatory assignments for both courses. The project was graded in both courses, comprising 10 % of the total grade for ICT students and 20 % for the IS students.
Schedule Prior to the project, students in both courses were given an introductory lecture on application sharing. In addition, the IS students were given some practical exercise with Microsoft NetMeeting. The project activities were scheduled as follows: Kick-off seminar at AUC Kristiansand. Introductory lecture on distributed collaboration. Forming groups, selection of topics. Lunch in groups, introduction/getting acquainted. 2 1/2 hours with group work on problem specification and planning. Concluding lecture on distributed teamwork. Distributed project work for two weeks. No face-to-face contact between participants from the two courses. Group members from same course allowed to work face-to-face. Each group assigned one instructor as supervisor. Closing seminar at AUC Grimstad. Video transferred guest lecture on digital communication and organizational challenges. Groups finalizing their presentations. Lunch. Group presentations in class.
Group composition 3 groups with 2 IS students and 4 ICT students, 1 group with 2 IS students and 3 ICT students, 2 groups with 2x4 ICT students in each. One ICT student as observer in each group. A total of 8 IS students and 31 ICT students.
Infrastructure The students in both courses had a dedicated PC lab at their disposal, offering access to the following technologies/applications: E-mail (MS Exchange Outlook in Grimstad and Eudora Pro 3.0 in Kristiansand) Microsoft NetMeeting v. 2.11/3.01 2 Intel Proshare workstations placed in dedicated rooms close to the PC labs at each site Lotus Notes v. 4.5 (Domino) World Wide Web (WWW) Mobile phones (used by the students as a supplement to the specified infrastructure)

Overall Evaluation of the Project

All groups presented a common web-site for their work and in general all main questions were answered (web-sites (in Norwegian) are available at http://ikt98.grm.hia.no/ikt4200/). Most of the presentations were of good quality and reflected that considerable work had been put into the projects. However, the quality of the web-sites varied significantly in contents and structure. The presentations showed that most of the groups had divided the tasks between the students in the two courses, so that the ICT students were responsible for the technical part related to the design and development of the web-pages, with the IS students as content providers. Still, the end product was more integrated and coherent than for the first pilot project.

Despite the course schedules being coordinated at the outset, some groups still reported difficulties in finding available time for synchronous meetings. As the number of part time students was greater this year, especially among the IS students, this meant that several of the students were only able to work on the project after normal hours.

One of the two groups comprising ICT students only reported that they had followed the instructions and simulated distributed collaboration, using electronic communication only. The other group felt it to be inconvenient and unnatural to use these communication services, as they in fact were working in the same PC lab. They had therefore chosen to complete the assignment in their "normal" way of working, using face-to-face meetings.

In general, the groups had very few questions for the supervisors this time. This can be explained by the relatively simple nature of the task, at least as compared to the assignment in pilot project 1.

DISCUSSION OF EXPERIENCES FROM THE PROJECTS

Use of Technology

The experience reports draw a fairly unambiguous picture of how the groups used the communication services and their evaluation of the different services. An overview of the services and their characteristic use is given in Table 3. The "noise" column indicates the level of experienced technical problems disturbing the communication. These include both "real" technical problems and problems caused by insufficient user competence. Use patterns for the individual services are elaborated in the rest of this section.

E-mail

The participating students can be characterized as experienced e-mail users. All groups reported frequent use and point to e-mail as the basic and most important service. Although mainly used for coordination and short messages, some of the logged messages also contain examples of "rich communication" (Lee,

TABLE 3
OVERVIEW OF TECHNOLOGY USE

Service	"Noise"	General use	Pilot project 1	Pilot project 2
E-mail	No	Service most used; messages, coordination, exchange of documents and information, short discussions		
NetMeeting	Considerable	Important service for most groups; application sharing, audio and some chat	Mostly used for one to one meetings; explaining concepts and demonstrating product	Mostly used as support for meetings with several participants
Video-conference	Considerable	Group meetings, not important	N/A	Experimental
Document repositories	Some	Repositories for common documents. Of moderate to high importance to some groups, not used by others.		
Web	Little	Information search, publishing of results, web interface to other services	Important, but not the only source of information	The only source of information
Mobile phones	No	Messages, coordination, "get in contact, backup audio channel	No use reported	Use reported by all groups

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1994). For example, we noticed a "heated discussion" that probably should not have been conducted through e-mail (the supervisor was cc'ed to be informed about lack of commitment from two members of a group). Another group reported a "dangerous situation" where the air was cleared by a phone call. Several groups pointed to or discussed limitations in the use of e-mail, e.g., difficulty in conducting longer discussions, a contextual information and information overload. However, it is difficult here to separate real experience from "show off" of the course curriculum.

NetMeeting (NM)

The students had relatively little experience in use of NM. Hence most of the groups used some time "troubling" and experimenting with the technology. NM supports multipart application sharing, whiteboard and chat. Unless you are connected to a Multipart Conferencing Unit (MCU), the audio and video connections only support two participants. This information was given to the students in lectures prior to both pilot projects. Still, most of the groups in the second project reported that they were not aware of this limitation and that they had spent much time trying to get a multipart audio conference working. In general, the audio quality is reported as a source of "technical noise. Several case studies report that normal practice in industry is to support multipart NM conferences with load speaking phones (Line, 1998; Mark et al. 1999). The students did not have access to this type of equipment and did not have their own cubicles or office spaces. This difference limits the potential use of the service.

Except for two groups (one in each pilot project), all groups perceived NM to be of practical use, and saw the potential for this type of service. The reported frequency of use was in average two-three times per week, with duration varying from 15 minutes to 3 hours.

In the first project, the most common use of NM was a meeting with two participants who both used headset with microphone. The typical use was mutual demonstrations of features in the two products that should be compared, discussion of the project report and discussion of the presentation material (PowerPoint documents). These sessions were reported to be focused and efficient. In some cases this practice was reported to be a source of "free riding, as expressed by the following statement from one of the groups:

> *the group members that do not participate in the discussions are not involved in the tasks in the same way. This may lead to less commitment and involvement.*

In the second project, NM was often used as a support for scheduled meetings that involved all group members. Overlooking the earlier mentioned "technical noise, the groups were mainly satisfied with these meetings. However, several noted that they regarded it as a formal tool, i.e. the communication channel did not sustain "small talk."

Videoconferencing

Videoconferencing was only available in the second conduct of the project. Some students had experience with use of the equipment, but unfortunately there was not time for systematic training of all groups. All groups used the equipment at least once. Some groups experienced "technical noise, probably caused by lack of experience and competence, "itchy fingers" and curiosity about the different features. The general impression is that they found it interesting and more informal then NM. The added value to the meetings was found to be relatively marginal.

Document Repositories/Discussion Databases

In both projects, several groups established some form of discussion database or document repository. These services were created by Lotus Notes/Domino/ Teamroom, Microsoft FrontPage and a Web based Extranet product. None of the groups reported any use of these services for real discussions. The normal use of these services was as a common document repository. To some of the groups, the work with establishing this service was also relevant for the assigned task (Internet integration and database structure in the first project, and document management in the second project).

World Wide Web (WWW)

The important use of WWW was information retrieval and publishing of the deliveries. Although not explicitly reported, the information search capabilities were more important in the second project due to the nature of the assignment. Some groups mentioned problems with finding relevant, unbiased and qualified information. The referenced material is to a large extent clearly biased (vendor data sheets, white papers,

etc.). Though not investigated in detail, it is our impression that most of the groups were aware of this and treated this type of information with necessary caution.

Almost all groups in the second pilot project appointed a "webmaster" responsible for the final publishing of the deliveries, or delegated this task to the ICT students in the group. Given the ICT students' former experience with and access to the web publishing tool, this can be seen as a natural decision and is not reported to have caused major problems for the work. Some groups used web interfaced document repositories. In the first pilot project, the web interface in Exchange/Outlook and Notes/Domino was used for remote access in comparison of the two products. Due to the limited features available in the web interface, most groups reported that NetMeeting was a more suited service to support this task.

Mobile Phones

The use of mobile phones is an interesting difference between the first and second conduct of the pilot project. In the second project, almost all groups reported use of mobile phones and that this use was efficient and valuable in various situations. All students were well acquainted with this "service" and therefore did not "stretch its limits" or "experiment" with its capabilities. The use was straight forward, such as contacting the other group, short messages, simple discussions and coordination of activities. Another valuable use was to serve as a backup communication channel in situations where the audio contact in NetMeeting or the videoconferencing system broke down.

General Reflections on the Use of Services

E-mail, and in the second pilot project also mobile phones, can be characterized as simple services with practically no technical noise. Given proper configuration and management of the network and workstations and sufficient training and experience in use of the services, it should be possible to remove the noise from the other services as well. This would probably have a significant impact on the combined use of the communication services. Earlier field studies show that it can take considerable time to develop new use patterns and exploit the full potential of a new service (e.g., Grudin & Palen, 1995; Line, 1998, Munkvold, 1999).

Evaluation of the Process

In the following, the work process during the projects and the final results presented by the students are evaluated. This evaluation is based on the experience reports, the post survey in the second conduct and subsequent discussions with the students. Unless explicitly mentioned, the evaluation is based on both pilot projects.

Organization of the Projects

The groups chose a flat structure with no formal leader. Most of the groups appointed a contact person responsible for coordinating the activities at each site. Coordination and finding time for synchronous sessions were reported as issues in both conducts of the project. In the second project, most of the groups acknowledged this responsibility and made clear appointments. Meetings including all group members were more used in the second conduct. Few groups appointed a meeting leader, but several reported a need for this.

In the second conduct most of the groups started with a division into subtasks and a relatively strong assignment of tasks. This assignment was mostly based on an evaluation of fair division of workload. Most groups appointed a web master.

Conflicts

The overall picture is that the conflict level was very low. Consensus was normally reached by e-mail discussions, NetMeetings or by phone calls. The main sources for the few escalated and surfaced conflicts we observed were:

- Broken appointments (in many cases due to unclear agreements)
- Lack of responsibility and commitment to assigned tasks
- "Us - them" issues

The conflict level in the two co-located groups comprising students from only one class was higher than in the distributed groups. Although we cannot draw any firm conclusions, the material from the two projects shows no indications of a raised conflict level or difficulties in solving potential conflicts in a distributed work setting.

We expected that the different professional perspectives in the two study programmes could be a potential source of conflict. Several differences, misunderstandings and potential conflicts were reported. However, these comments are outweighed by positive statements of how the students found it interesting and instructive to meet and work with people taking on a different approach to the assignment.

Efficiency

The general feedback is that the efficiency of the work was experienced as acceptable, but slightly reduced by the distributed setting. When measured against the students' expectations as expressed in the pre survey, the post survey indicates that the students experienced slightly higher efficiency impact than expected. The main cause of efficiency loss was technical noise and lack of experience with this way of working. The initial meeting at the kick-off seminar was also reported by most groups to be important for the communication in the distributed project period.

Quality of Outcome

In the first conduct of the project most of the groups were not content with the quality of the final product. The open ended and complex assignment together with technical noise with the communication services were stated as reasons for this. This is also in line with our evaluation of the project reports. Only two groups managed to compare the products using a common terminology. The rest of the groups mostly described "their" product using the vendor's terms.

For the second pilot project the assignment was made simpler and more specified. In this conduct the majority of the students were content with the quality of the group's work. Approximately 50% of the students thought the group's result would have been better if the group had been co-located during the project. None of them refer to specific problems that affected the quality. The general response is that communication would have been easier in a co-located context. Our evaluation of these reports is that all groups have answered all questions and managed to deliver a common product. We noted that several of the groups had closed important questions early, such as selection of products to compare and framework for comparison, without consulting the supervisors first.

Satisfaction with Learning Experience

The general picture is positive. The projects were characterized as interesting and instructive and the students claim to have achieved a better understanding of possibilities and limitations with distributed collaboration. In the first conduct, the students reported that the project was very demanding, both with respect to the complexity of the assignment and the total time spent on the project.

Technical noise was reported to be a source of frustration. On the other hand, we also have statements where experimenting with the communication services was regarded as an integrated objective in the project.

As can be expected, the ICT students participating in co-located groups reported less positive experiences than the rest. The "faked distributed setting felt unnatural, and they did not get the right experience of being dependent on the communication services.

Half of the students reported that they would have preferred to travel for working face-to-face, if given the resources. On the other hand, the survey shows that the students found working in a distributed team to be satisfactory. In other words, distributed collaboration is not their first choice, but they do not regard it as a major barrier either. In many ways, these statements are in line with the learning objectives of the projects, i.e. to give the students a balanced understanding of the potential and limitations of distributed collaborative work.

CONCLUSION AND IMPLICATIONS

The two pilot projects presented in this study illustrate how practical training in distributed collaboration can constitute an important part of the curriculum in graduate IS/ICT programmes. The students report a high learning outcome and perceived benefit from participating in this type of project. Task definitions and balancing of motivational factors were found to have a great impact on the groups' efforts, sharing of workload and final outcome. Further, the projects also illustrate how technical noise and lack of experience with the technologies have represented barriers to effective collaboration, implying a need for training the students in integrated use of different communication services.

The study provides a valuable experience base for planning similar student projects in the future. In the following, the major implications for conducting this type of project are summarized. In addition, we discuss some implications for practice that can be inferred from our results. Finally, although the focus of this study has been on building practical experience on training students in distributed collaboration, we also present some suggestions for further research related to distributed collaboration in general.

Implications for Training in Distributed Collaboration

Several implications can be drawn from the two pilot projects regarding design and conduct of this type of project:

Group composition
The experiences from the two pilot projects imply that the ideal group size would be two participants from each course. More than four members may result in "free-riding, and also represents a limitation when using tools like NetMeeting. In larger courses with a large number of groups, the topics for the assignment can be duplicated if necessary.

The distributed context needs to be "real"
The problems experienced by the two co-located groups in the second pilot project, illustrate the difficulty of "simulating" distributed collaborative work. Without real geographical dispersion, it is difficult for the students to restrict their communication to using electronic media only, when other group members are available for face-to-face contact next door, or even in the same PC lab.

Selection of tasks
In projects comprising members from different courses, it is vital that the nature of the task is cohesive, in the sense that it does not stimulate factions or polarization. Thus, tasks with an inherent "us-them" nature should be avoided. To reduce the students' uncertainty and enable them to quickly get started on the project collaboration, having a well-defined task seems appropriate. However, this needs to be balanced against the important learning process that may take place through "frustration" and problems related to project definition and delimitation of focus. Examples of tasks considered to be well suited are design of a simple software application, product evaluation (with no students perceiving any "ownership" of the products to be evaluated), or analysis of a collaboration problem and development of suggestions for technology support.

Scheduling of the project
The exposure of knowledge to "strangers, plenary presentation and grading of the project all constitute strong motivational factors. Thus the students may easily end up using more time on the project than allocated. As illustrated by the first of the pilot projects, this may especially be the case if the task is equivocal in nature. The duration of the project period therefore needs to be adapted to the nature and complexity of the task, and the time available for the students to work on this. In general, initial hands-on training in the use of the different communication technologies will enable the student groups to arrive at a functional stage earlier. Further, both projects illustrate that finding time for synchronous meetings may be difficult. This can be eased somewhat by coordinating the course schedules for the different student groups. However, it is important that the students remain responsible for scheduling and coordinating the meeting activities.

Establishing a common level of technical skills prior to the project
A common platform needs to be established regarding basic skills in use of the technologies to be deployed. This may for example include practical training in the use of NetMeeting prior to the project. Although it is important that the students themselves discuss and develop routines for coordination of the work and use of the technologies, we recommend presenting some "practical advice" at the outset on how to effectively deploy the technologies in distributed project work.

The students should be given the possibility for an initial face-to-face meeting
The students reported that they perceived the initial face-to-face contact during the kick-off seminar to be of great importance for building relations, and believed this to have significant influence on the process and quality of outcome of the teamwork. If possible, we therefore recommend that the students be given this opportunity. This also seems to fit well with the practice that can be observed in "real" projects, where face-to-face meetings are given priority in

the early stages of a project. From a research perspective it could here also be possible to apply a design where half of the groups are given the opportunity to meet face-to-face for the first seminar, then comparing the process and outcome for these groups with groups not given this opportunity. However, this may introduce problems in grading the projects for the two categories.

Balancing of motivational aspects
To avoid any bias in motivation and efforts for students from different courses, the evaluation form and incentives should be made as equal as possible. This includes grading and credits given for the assignment in each course.

Use remote supervision when needed
One supervisor should be assigned per group, regardless of geographical location. Technologies for supporting distributed collaboration should be applied for remote supervision when needed. This may also add to the students' experience from the project.

Experience reports may stimulate the students' reflection on the work process
By making experience reports part of the mandatory assignment, the students are stimulated to also reflect upon process aspects of the project work. However, it is important to have the groups assign a person responsible for keeping an activity log related to this, or else this may run the risk of getting low priority compared to the other project work. Further, the expected contents of these reports should be stated explicitly at the outset.

Implications for Practice

The setting created for these pilot projects is not far from work situations the students can expect to meet in their working life. However, we advocate caution in transferring results from an educational setting to a "real organization. We therefore only discuss some experiences that corroborate results from earlier field studies conducted in a real setting (Line, 1999a).

Application sharing can be an efficient tool to support discussions related to various information objects like drawings and reports. The audio quality is still not sufficient for using NetMeeting as a standalone conferencing tool. This can be solved by using conferencing phones for the audio communication part.

"Collaboration across distance demands competence and training to be efficient. This statement from one of the experience reports underpins the need to establish procedures and structures for efficient use of the various technologies. Training in basic skills is critical in order to establish the right motivation for use. Without "hands-on" experience, very few are able to relate to and see the potential benefit of technologies like application sharing and document repositories. Although there exist studies that can be seen as a first approach towards establishing best practice in this area (e.g., Mark et al., 1999), it is however difficult to define context free guidelines. The individual organization must develop its own procedures and use patterns based on its needs and accumulated experience (Line, 1999b; Munkvold, 1999).

Implications for Further Research

There still exists little research on distributed collaboration that focuses on efficient, combined use of several collaborative technologies or services. We argue that there is a need for studies applying a holistic view on communication needs in distributed projects, looking into interdependencies and interplay among several services that together may constitute an infrastructure for distributed collaboration. This is accentuated by the rapid development of Mobile Internet services based on technologies like WAP, UMTS and Bluetooth, and is also exemplified by the new role taken by mobile phones as a supporting service in the second pilot project. A holistic view considering possibilities and limitations for integration and interoperability of different technologies and services is therefore necessary for understanding how new, efficient use patterns can be developed.

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